DIGITAL HEALTH: CHALLENGES AND OPPORTUNITIES SHOWCASED AT THE 2018 ESC CONFERENCE IN MUNICH

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At the European Society of Cardiology Annual Scientific Meeting in Munich in August 2018, there was a digital area, where the full range of digital technologies were discussed. The area was extremely popular, with standing room only for nearly all sessions.

It is impossible to cover all of the excellent presentations on digital health, but the ones that caught my eye are mentioned below. Please go to the ESC website for more detail regarding the presentations (see callout box).

mHEALTH, INCLUDING APPS

Mobile health (mHealth) includes many technologies, including "applications" (apps) that can be downloaded onto a smartphone. These are very popular and many of us use these to manage our bank accounts, book and check-in to flights, watch films, and catch up on the news. There are more than 300 000 medical or health and lifestyle apps, and it is impossible to keep up to date with all that is available.

At the 2018 ESC conference, we highlighted some of the most interesting and potentially relevant apps for the prevention, diagnosis, and treatment of cardiovascular conditions. My personal favorites were related to helping people manage their own condition better.

SMASH™ is an app that helps patients remember to take their medication, but many others exist. It was interesting to see the results of a randomized trial in Australia in 163 patients with coronary heart disease, with an average age of 58, who were taking an average of 4.2 medications each. Patients were randomized to usual care, a basic medication-reminder app, or a more interactive app that could be customized to the patient. Even the basic app improved medication adherence significantly at 3 months (as measured by the Morisky Medication Adherence

Scale-8), reducing the low adherence group from 29% of patients to 19%. The basic app seemed to be as effective as the more interactive and customizable app. Longer-term data, including the effect on blood pressure and lipid control would be good, but even these early results are likely to encourage cardiologists to recommend this (or similar apps) to their patients.

The BNK CardioCoach™ is an app that has modules for patient medical records, vital sign monitoring collected from, eg, home blood pressure devices, medication record and reminders, activity data and reminders, and a summary screen that provides the doctor with all of the key information from recent months on one screen. The patient controls who can access the data. Other similar apps were also presented, all with the underlying concept that the data being collected belongs to the patient, it can be collected and summarized, and used to enhance adherence to lifestyle and medication prescriptions, and facilitate efficient communication between the patient and the doctor or nurse at a clinic visit. We all know how frustrating it is for both patients and health care professionals if information is missing or only available after minutes of activity trying to get into different databases! It is likely that the use of such apps will increase as patients and health care professionals become more familiar with the technology. Perhaps, in the future, patients will no longer need to take sheets of paper out of their pockets with lists of blood pressure or weight details, but just email or Bluetooth to us a summary screen of all of the relevant information.

The ESC is increasingly using apps to support implementation of its guidelines and to support and educate patients. A good example is the ESC CATCH-Me apps, including AF Manager™ and MyAF™, the first helps health care professionals manage atrial fibrillation better and the second helps patients in terms of education, an atrial fibrillation diary, and collection of quality of life data. For both apps, UK, Japan, and Germany were the countries where the most downloads have taken place.

Dr Enrico Caiani, Associate Professor of Biomechanical Engineering and e-health and the past Chair of the e-cardiology working group of the ESC, presented a lecture on the evaluation of apps. He pointed out that it is difficult to navigate through the hundreds of thousands of apps in the health and lifestyle or medical categories. Most apps are downloaded from Google Play, with the Apple Store being the next most popular site. It is important to realize that the availability of an app does not mean that its content has been fully and independently validated. When you search for an app, they are generally listed in order of popularity, not necessarily the ease of use or the strength of evidence for any benefit for the user. Approximately 75% of apps are produced by individuals, with no connection to scientific or academic organizations, health care, or industry.[1] Only 0.5% are considered “medical devices” by regulators, and those apps undergo intense

scrutiny and are usually related to a technology that is considered medical, such as an implantable device or a diagnostic platform. All other apps are likely to be only minimally assessed from a medical perspective.

The European Commission undertook a public consultation on mHealth in 2014, and set up a working group of key stakeholders, including patients, health care professionals, payers, and social insurance companies, industry, public authorities, and academics. Sadly, even a minimal level of consensus was not reached and it was impossible to provide and endorse any guidelines. Several national initiatives are underway, including "AppSalud" in Andalucia and "AppSalut" in Catalonia, and assessment by NHS Digital and the National Institute for Health and Social Care (NICE) in the UK. Only a handful of apps have been endorsed and even fewer subjected to more formal and robust assessment of their health care impact and cost-effectiveness. Some professional organizations have started to endorse apps, but the ESC has yet to embark on such a process.

REMOTE MONITORING

Remote monitoring has been a hot topic in heart failure for some years. It has been technically feasible to collect data remotely, either from stand-alone systems or from implantable devices, for more than a decade, but the challenge is to demonstrate the benefit that this brings, particularly when producing such data streams requires redesigning the health care pathway, and identifying new responsibilities within the health care professional team.

At the 2018 ESC conference, Dr Friedrich Koehler from Berlin Charité presented the long-awaited results from the TIM-HF2 trial (NCT01878630).[2] A total of 1538 patients with a hospital admission for heart failure within at least the past 12 months, currently in NYHA class II or III, and without depression were randomized to usual care or remote monitoring for 12 months with a daily review of symptoms, blood pressure, weight, and ECG by a centralized telemonitoring center that was working 24/7. This monitoring center was in direct contact with the patient, the general practitioner, and the local cardiologist in 14 metropolitan and 11 rural areas, covering virtually the whole of Germany. The average age of the patients was 70, 70% were male, with an average ejection fraction of 41%, and patients were recruited on average 3 months after the last hospital admission.

The primary end point (percentage of days lost to unplanned cardiovascular hospitalizations or all-cause death) was reduced from 6.6% to 4.9% (P=0.046). The days lost to either an event during the year averaged 24.2 in the usual care arm and 18 in the remote monitoring arm. It is important to note that patients were well treated at baseline (90%+ on a RAS inhibitor and β-blocker, 55% on an aldosterone antagonist, 30% had an implantable cardioverter defibrillator, and 15%

had cardiac resynchronization therapy). The secondary end point of all-cause mortality was reduced by 30% (95% CI, 4%-50%; *P*=0.03), driven by a slightly larger, but notionally nonsignificant reduction in cardiovascular mortality (relative risk reduction, 33%; *P*=0.056). There was no change in overall quality of life or in plasma NT-proBNP concentrations, but the days lost to an unplanned heart failure hospitalization were reduced from 5.6 to 3.8 (*P*=0.007).

The investigators argued that a remote monitoring program with a well-structured telemedical center providing 24/7 services is an effective approach to overcoming regional differences in heart failure management. In other words, the expertise comes to the patient, rather than the other way round, and patients gain the benefit of more standardized care across the whole country. In an accompanying editorial to the simultaneously published paper in *The Lancet*,[2] Cleland and Clark suggest that the evidence for the mortality benefit of remote monitoring in heart failure is accumulating and that guideline writers should now be supportive and consider the totality of evidence available.[3]

WEARABLE TECHNOLOGIES

An example of a wearable technology that caught my attention was Cardioskin™, which is a 15-lead ECG recording system embedded in a T-shirt that is washable and can be worn for days to weeks. The ECG can be transmitted continuously or stored in a memory card that is easily clipped to the T-shirt. It has been given FDA Class II 510(k) clearance, and it may well become a replacement for the traditional Holter-recording, as the electrodes embedded in the T-shirt are more comfortable to wear than conventional electrodes, and this approach can provide the more prolonged monitoring that is needed to confidently exclude paroxysmal arrhythmia. The ECG interpretation software is of high quality, and, with the good-quality signal identification of a clinically important arrhythmia, without numerous false positives, appears promising.

REMOTE MONITORING OF HEART FAILURE USING IMPLANTABLE TECHNOLOGY

A prize was awarded for the best presentation in the "Heart Failure and Digital Health" session to Dr Darshan Brahmbhatt, from the Royal Brompton Hospital, London. He presented the results to date from the HeartLogic™ multiparametric monitoring algorithm, which uses data from CRT and ICD devices to determine whether the heart failure syndrome is deteriorating. The algorithm integrates information from the intensity of the heart sounds (reflecting intraventricular pressure), respiratory rate and volume, transthoracic impedance, patient activity, and nocturnal heart rate. An alert is triggered by the algorithm if these parameters head in the wrong direction, and the health care team typically would telephone the patient and advise an increase in diuretic therapy until the alert re-

sets. Learning from previous approaches to remote monitoring with implantable devices, data from a large number of patients was used to develop and validate the algorithm, and currently a randomized outcome study is underway in the USA to determine if this approach can be used in routine practice to reduce the mortality and heart failure hospitalization rate in patients with heart failure and an implanted device (MANAGE-HF; NCT03237858). Early experience suggests that it is vital to integrate the data flow into the decision-making pathway at each institution and that monitoring staff act on the information quickly.

Interestingly, the chief investigator for the development and validation of the HeartLogic™ algorithm, Dr John Boehmer from Penn State Milton S. Hershey Medical Center in the USA, has taken the same multiparametric monitoring concept and applied it to a wearable undergarment using nanosensors. FDA Class II 510(k) clearance has been given, and the team is undertaking pilot work before starting a randomized validation trial called NanoSENSE using this undergarment.

ARTIFICIAL INTELLIGENCE

Artificial intelligence and machine learning are always topics of great interest to cardiologists, as well as to the general public. It has been interesting to see the evolution of the terminology used to describe this, moving from "disruptive" to "supportive," with the increasing realization that, for most tasks, such an approach supplements human decision-making and interaction, rather than replacing it.

Obvious areas of application include pattern recognition of images, using echocardiographic or CT- or MRI-based images. In theory, a patient's data can be analyzed more accurately by these algorithms than they can be by humans, using learning informed by hundreds of thousands of scans rather than merely thousands. How such approaches fit into the current image interpretation approach in cardiology remains to be seen, but undoubtedly, change is on the way.

More generally, computer-aided decision support is increasingly used in medical care to reduce the risk of mistakes and to ensure that management decisions are informed by the best current evidence. IBM-Watson has often been showcased in the media regarding decision support in the world of oncology, but, at the 2018 ESC conference, other approaches were also discussed. CardioNexion™ presented data on the use of artificial intelligence to supplement human intelligence when it came to long-term monitoring of the ECG in patients living their daily lives. The problem with many technologies is the false positive alert, requiring the cardiologist to view the ECG; the CardioNexion™ system appears to reduce the false positive rates to a low level, thereby allowing the cardiologist to concentrate on the (occasional) ECG that might influence clinical decision-making.

Another look toward the future was given by CardioCube®, where an "intelligent voice assistant," such as some 70 million households now have in their homes, can interact with patients and their physician to capture information for the electronic health record automatically, take a history, monitor symptom control, and use machine learning to identify key information that might influence medical decision-making.

SOCIAL MEDIA

There were several sessions on social media, helping to educate and inform cardiologists about the opportunities of these platforms for education and case-based learning, but also to show how the clinical community (or at least a broad section of this) is reacting to new trial results or updates to the guidelines. Some of the potential problems were also highlighted, including public access to tweets or other material. My own experience with social media around the conference was that #ESC2018 and #ESCdigital were good hashtags to "follow"; they certainly showed me what had caught people's attention and linked me in to other material that was useful.

The ESC Annual Scientific Meeting in Paris in 2019 will be bigger and better when it comes to digital health. Stay tuned for updates on the Escardio.org website (bookmark https://www.escardio.org/Education/Digital-Health-and-Cardiology) or follow @Escardio or search with #ESCdigital on Twitter. ■

Full resources from ESC 2018 in Munich are available at:

https://www.escardio.org/congresses-&-events/esc-congress/congress-resources

Also includes ESC 365 and ESC TV

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